IN THE UNITED STATE PATENT AND TRADEMARK OFFICE

In re application of :
Keishi NAKAMURA et al. :
Serial No. 09/825,446 : Group Art Unit 2832
Filed April 4, 2001 : Examiner K. Easthom
LOW RESISTANCE VALUE RESISTOR

VERIFYING DECLARATION

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

I, Shintaro Hotta, declare and say:

that I am thoroughly conversant in both the Japanese and English languages;

that I am presently engaged as a translator in these languages;

that the attached document represents a true English translation of Japanese Patent Application No. 2000-102616 filed in Japan on April 4, 2000

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that there statements were made with the knowledge that willful false statements and like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 24th day of July, 2002

S. Hotta

TRANSLATOR

Filing Date: April 4, 2000
Application No. 2000-102616

Reference No. KA089P

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(PROOF) Yes

(NAME OF DOCUMENT) SPECIFICATION

(TITLE OF THE INVENTION) LAW RESISTANCE VALUE RESISTOR

(CLAIMS)

(CLAIM 1)

A low resistance value resistor comprising:

a resistor body being made of a metal material; and

metal strips being affixed as electrodes on said resistor body by means of rolling and/or thermal diffusion bonding.

(CLAIM 2)

A low resistance value resistor comprising:

a resistor body being made of a metal material; and

fused solder layers being affixed as electrodes on said resistor body.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(TECHNICAL FIELD TO WHICH THE INVENTION BELONGS)

The present invention relates to a low resistance value resistor having electrodes at both ends of the resistor body.

(0002)

(PRIOR ART)

Low resistance value resistors made of a plate or ribbon type resistor body of metal material having electrodes at both ends of the resistor body are widely used such as a resistor for a current detector etc. because of their characteristics of their good heat dissipation and high current capacity. Resistor metal materials serving as a resistor body include, for example, copper nickel alloys, nickel chromium alloys, iron chromium alloys and manganin type alloys, and electrodes are provided at both ends of the resistor body. Conventional resistors are generally those types that electrodes are electroplated on the resistor body mentioned above.

However, it is difficult to form a thick layer on the resistor body by electroplating, and therefore, it is difficult to attain uniform distribution of voltage potential in the electrode. This makes the current path unstabilized and makes it difficult to fabricate low resistance value resistors with high precisions. Also, because the bonding strength is low between the metal material constituting the resistor body and the electroplated electrode, some problems occur that it is weak as to mechanical, thermal and electrical stresses, in case that the resistor body is utilized in a bent form.

(0004)

Also, in some cases of producing low resistance value resistors, a metal strip of a copper or nickel thin film is affixed to the resistor body as an electrode, by means of electron beam welding etc., instead of electroplating. Even in such cases, because the welded point between the strip and the resistor body is formed in a small limited area, similar problems of insufficiency of joining strength and non-uniformity of current distribution occur.

(0005)

The present invention is provided in view of the background described above and the objective of the present invention is to provide a low resistance value resistor having an electrode structure that has high joining mechanical strength sufficient enough for applications and excellent uniform current distribution.

(0006)

(MEANS FOR SOLVING THE PROBLEMS)

According to claim 1 of the present invention, there is provided a low resistance value resistor with a resistor body being made of a metal material, wherein the metal strips are affixed as electrodes on the resistor body by means of rolling and/or thermal diffusion bonding.

(0007)

The low resistance value resistor is made by joining thin metal strips on both

diffusion bonding. There is a difference comparing from the electrodes made by electroplating or welding, in that the metal strip affixed by such rolling and/or diffusion bonding forms a diffusion layer at the interface of or inner side of the metal material of the resistor body. Because of the presence of the diffusion layer, the electrode is bonded strongly to the resistor body and therefore a uniform current distribution is obtained. The electrode structure of the low resistance value resistor thus produced is therefore stable to various stresses, including mechanical, thermal, electrical and other stresses.

(0008)

According to claim 2 of the present invention, there is provided a low resistance value resistor with a resistor body being made of a metal material, wherein fused solder layers are affixed as electrodes on the resistor body.

(0009)

Although the fused solder layer formed on the surface of the metal body is very thin, for example, in the range of several micrometers, the fused solder layer is formed so that fused solder is diffused into the metal body of the parent metal. The electrode is bonded strongly to the resistor body and uniform current distribution is obtained due to the presence of the solder diffused layer. Therefore, like the case as described above, the electrode structure of the low resistance value resistor thus produced is stable to various stresses, including mechanical, thermal, electrical and other stresses.

(0010)

(EMBODIMENT OF THE INVENTION)

Preferred embodiments will be explained in the following with reference to the drawings. FIGS. 1(a) and (b) show examples of the structure of a low resistance value resistor in the first embodiment of this invention. As shown in the diagram, the resistor is provided with metal strip members 12 and 13 bonded to both ends of the resistor body (parent metal) 11 by means of rolling and/or thermal diffusion bonding. In these examples, the metal strip members 12, 13 are inlaid in the parent metal i.e. the resistor

preferably of a copper nickel alloy, a nichrome alloy or an iron chromium alloy. The metal strip members, which are to be joined to the parent metal by rolling and/or thermal diffusion bonding, are thin plates made of copper or nickel and have a thickness of about 50 to 200 μm.

(0011)

This low resistance value resistor has, for example, an extended length of about 20 mm or less, a width of about 5 mm and the metal strip members are bonded so as to be about 2.5 mm away from the each end of the resistor body. By the way, the parent metal has a thickness of about 150 to 600 μm. In this way, a low resistance value of several mΩ to several tens of mΩ can be obtained. Although in this embodiment the low resistance value resistor has a so-called inlay cladding structure that the inlaid metal strip members, which are to be joined by rolling and/or thermal diffusion bonding, are inlaid to the parent metal, the low resistance value resistor may also has a so-called top-lay cladding structure that metal strip members are placed on a flat parent metal and are joined to the metal by rolling and/or thermal diffusion bonding.

(0012)

A low resistance value resistor of this type of structure is manufactured firstly by preparing a metal material to be used as a parent metal, and secondly by joining the metal strips on both ends of the metal material by rolling and/or thermal diffusion bonding. The rolling and/or thermal diffusion bonding is carried out by applying heat so as to keep a required temperature under pressure. This makes a diffusion layer of the metal strip material at the adjoining interface or in the inner side of the parent metal. After being completed of the bonding step, the bonded material is cut into units of a predetermined length and these units are finished by being bent into the shapes shown in FIG. 1(a) or (b). By the way, in case of manufacturing a low resistance value resistor of the type of the inlay cladding structure, it is necessary to make grooves in the parent metal preliminary, before inlaying the metal strips.

The low resistance value resistor thus manufactured does not show any problem, such as cracking or peeling, in electrodes in the course of the bending processing of the resistor into shapes illustrated in FIG.1 (a) and (b), because the electrode sections produced by rolling and/or thermal diffusion bonding have a sufficient mechanical strength against bending stresses. Also, because the current distribution in the electrode is uniform, a low resistance value resistor thus manufactured shows superior electrical properties. Therefore, in case that the resistor is to be mounted on a printed circuit board, the resistor can be stably mounted without suffering any trouble due to mechanical, thermal, electrical and other stresses, because it shows an excellent performance against these stresses. Also it can minimize the time-depending drift in performances after being mounted on the printed circuit board.

(0014)

FIGS. 2(a) and (b) show other examples of the resistor structure in the second embodiment. The metal material to be used as a parent metal of the low resistance value resistor is generally made of a copper nickel alloy, a nichrome alloy, and a manganin type alloy etc., essentially the same with that in the first embodiment. The resistor is provided with fused solder layers at both ends of the resistor body 11, which serve as electrodes 15 and 16. The electrodes of the fused solder layers are formed by diffusing the fused solder into the surface of the resistor body, and their thickness are as low as in the range of several micrometers. The fused solder layers thus formed are excellent in the mechanical strength and the stability of the current distribution compared to the conventional electroplated or welded electrode structure, due to the presence of the diffusion layers at the interface of the resistor body or in the inner side of the resistor body.

(0015)

Although the layer thickness is as low as several micrometers, these layers show excellent characteristics against the bending work and also show an extremely low

type of resistor will provide a superior temperature coefficient of resistance (TCR) compared to the conventional resistors having an electrode structure with welded copper strips or electroplated films. For example, on one hand, the change of the resistance of an electroplated electrode in a given interval of time is about 0.5-2.0 %, on the other hand, the change of the fused solder layer electrode is as low as 0-0.1 % in the same interval of time and the latter value is differed from the former by far. As to the temperature coefficient of resistance (TCR), a copper metal has a value of 4000-5000 ppm/°C, whereas the fused solder layer electrode has a value of about 2000 ppm/°C.

(0016)

Further, with the fused solder layer electrode, the soldering without lead for connecting wires can be facilitated. Thus, various solders including those without lead can be utilized to mount the resistor, in the case of mounting the resistor on printed circuit board and the like. Accordingly, the electrode structure of the present invention is well applicable in the various environmental concerns.

(0017)

It should be noted that the shapes, dimensions, etc. of the low resistance value resistor described above are only examples, and it is obvious that various modifications of the embodiments described above can be devised within the scope of the present invention.

(0018)

(EFFECTS OF THE INVENTION)

As explained heretofore, according to the present invention, a low resistance value resistor with such an electrode structure is provided that has a good electrical characteristics and also has a sufficiently high mechanical strength.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(Fig. 1)

first embodiment of the present invention.

(Fig.2)

FIG. 2 (a) and (b) are perspective views of a low resistance value resistor in the second embodiment of the present invention.

(DESCRIPTION OF THE REFERENCE NUMERALS AND SIGNS)

11	resistor body (parent metal)
12, 13	electrodes made of a metal strip affixed by means of rolling and/or thermal diffusion bonding
15, 16	electrodes formed with a fused solder layer

(Designation of Document) ABSTRACT

(Abstract)

(Problem) To provide a low resistance value resistor having an electrode structure that has high joining mechanical strength sufficient enough for applications and excellent uniform current distribution.

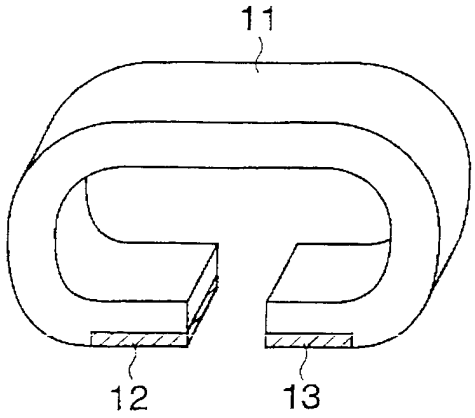
(Means for Resolution) A low resistance value resistor comprises: a resistor body 11 made of a metal material; and metal strips 12, 13 being affixed as electrodes on said resistor body by means of rolling and/or thermal diffusion bonding. Also this resistor body may be provided with fused solder layers.

(Selected Figure) Fig. 1

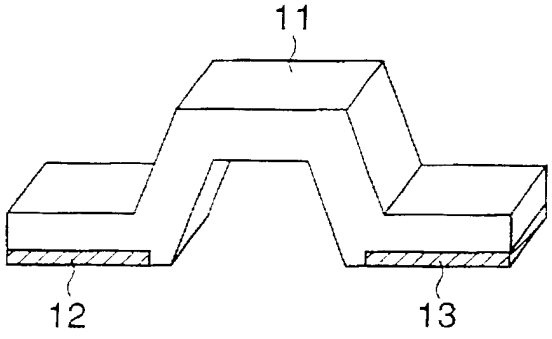
(NAME OF DOCUMENT)

(FIG. 1)

(a)



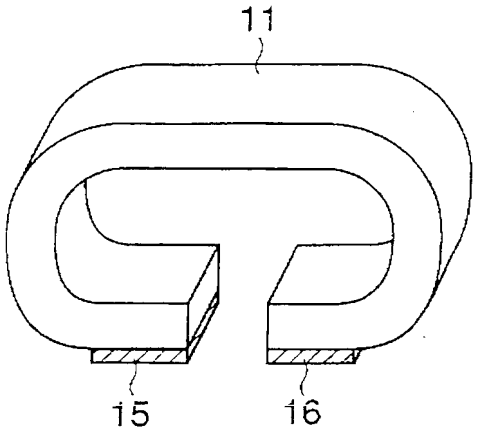
(b)



Reference No. KA089P

(FIG. 2)

(a)



(b)